A SYSTEMATIC STUDY OF THE MAIN ARTERIES IN THE REGION OF THE HEART—AVES—III.

THE FRINGILLIDAE. PART I

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INTRODUCTION

Recently the writer has discussed the arrangement of the arteries in the region of the heart of birds (3, 5, 6), the presence of a functional left radix aorta in the Kingfisher (2), and the presence of the ligamentum botalli in three species of birds (4).

In an earlier paper (3), the writer has pointed out that, according to Beddard (1), the left carotid artery alone persists in the Passeres—now Passeriformes. It has been this writer's experience that this is not the condition in the American passerine birds. Studies carried out on 30 species of the Fringillidae have resulted in the observations which are set forth in this paper.

MATERIALS

Routine dissections and observations were made on 30 species of the family Fringillidae in the preparation of this paper. Specimens were obtained from the United States National Museum, the Cleveland Museum of Natural History, and the Summit County Wildlife Research Station, Akron.

Specimens of the following species of birds were selected for study: *Carduelis carduelis, Certhidea cinerascens, Coryphospingus pileatus, Emberiza aureola, Emberiza flaviventris, Fringilla coelebs, Fringilla montifringilla, Geospiza f. fuliginosa, Geospiza s. septentrionalis, Guiraca caerulea, Hedymeles ludovicianus, Junco h. hyemalis, Leucosticte griseonucha, Loxigilla violacea affinis, Loxigilla noctis sclateri, Loxipasser anoxantha, Melospiza m. melodia, Melopyrrha nigra, Paroaria capitata, Passerculus sandwichensis savanna, Pipilo e. erythrophthalmus, Pipilo fuscus mesoleucus, Pyrrhula pyrrhula, Richmondena c. cardinalis, Spizella m. monticola, Spizella p. passerina, Spizella p. pusilla, Sporophila aurita, Tiaris bicolor omissa,* and *Tiaris o. olivacea.*

Results of this study are set forth in the following observations:

OBSERVATIONS

With reference to the main arteries in the neck and thorax, the basic arrangement-pattern is the same as that in other passerine birds, and differs only in certain details. The greatest divergence within the family results from retention (as vestiges) of certain embryonic vessels. The more important of these vestiges are derived from (1) the left radix aorta, (2) the distal portion of the 6th aortic arch, and (3) the ductus caroticus. In all cases where the above mentioned vestiges are found to persist, they remain as ligamentous vestiges of the embryonic vessels and not as functional vessels in the adult bird.

Among the Fringillidae the following arrangement-pattern is basic. The innominate arteries arise from the aortic root and then pass forward and to the left and right sides of the median-longitudinal axis of the body. The right innominate artery gives rise to the right systemic arch which then continues posteriorly to form the dorsal aorta. The right innominate then gives rise to the right common

carotid artery and the subclavian artery. From its origin in the innominate artery, the common carotid passes anteriorly to the thyroid gland where it sends off a short thyroid artery, and then gives rise to several branch arteries: (1) the ventral external artery which supplies the trachea and other ventral neck tissues; (2) the lateral external artery which serves as an ascending oesophageal artery as well as the main supply for the lateral cervical musculature and lymphatic glands of the right side of the neck; (3) the vertebral artery which passes dorsally and then anteriorly in the region of the brachial plexus. The left innominate artery gives rise to the common carotid and subclavian arteries on the left side. The left carotid then passes anteriorly to the thyroid gland, sends off a short vessel to the thyroid, and then gives rise to two branches; the larger forms the ventral internal carotid which enters the hypapophysial canal; the other gives rise to the lateral superficial vertebral and the cervical carotid. Both left and right lateral cervical and the right ascending oesophageal are superficial vessels. The left lateral superficial supplies the tissues along the left side of the neck in much the same manner as does its complimentary right vessel. The subclavian arteries (left and right) give rise to (1) the coracoid major, (2) the internal mammary, (3) the axillary, and (4) two pectoral arteries (Fig. 1).

The above condition, without ligamentous vestiges of the embryonic vessels, is found in *Emberiza aureola* (291235)[1], *Geospiza f. fuliginosa* (224902), *Guiraca caerulea* (33978), *Melopyrrha nigra* (321134), and *Paroaria capitata* (227245). Slight modifications of this condition are found in the following 25 species which were studied.

Loxipasser anoxantha (41994) retained the ligamentum caroticum—the anterior insertion of which is located on the right common carotid artery (near the thyroid gland) and the posterior insertion on the right radix aorta, at its junction with the 4th right aortic arch (Fig. 2).

Loxigilla violacea affinis (225921) revealed the presence of a complete ligamentum caroticum, the ligamentous vestige of the left radix aorta, and (for a short distance along the right radix aorta) the distal portion of the right ligamentum botalli (Fig. 3).

In *Pipilo fuscus mesoleucus* (4310), the distal portion of the right ligamentum botalli persists, but the proximal portion is completely atrophied, and the left radix aorta possesses a lumen for a short distance. The anterior or distal portion of the left radix remains as a ligamentous vestige of the embryonic vessel (Fig. 4).

Richmondena c. cardinalis and *Spizella m. monticolla* are alike in arrangement. In both species the left radix aorta persists as a ligamentous vestige, and the ligamentum botalli is complete, attached to both the pulmonary artery and the right radix aorta (Fig. 5).

Leucosticte griseonucha (321135) lacks the right ligamentum botalli, but the left ligamentum botalli is present as is the ligamentous vestige of the left radix aorta and part of the presumed left 4th aortic arch (Fig. 6).

In *Junco h. hyemalis, Loxigilla noctis sclateri* (318215), *Melospiza m. melodia, Passerculus sandwichensis savanna, Pipilo e. erythrophthalmus, Spizella p. passerina,* and *Spizella p. pusilla* the left radix aorta remains as a fairly prominent ligamentous vestige; in *Carduelis carduelis* (226944), *Certhidea cinerascens* (321936), *Emberiza flaviventris* (227048), *Hedymeles ludovicianus,* and *Tiaris bicolor omissa* the left radix is reduced to a long thin very minute ligament; and in *Coryphospingus pileatus* (321953), *Pyrrhula pyrrhula* (292957), and *Sporophila aurita* (343928) the left radix remains as a short, though readily visible ligament. Still further reduction and modification of the left radix occurs in *Fringilla montifringilla* (291236) and *Tiaris o. olivacea* (291958), (Fig. 7). In the latter, it remains as a mere ligamentous button on the left side of the dorsal aorta, just anterior to the coeliac artery. In *Passerculus sandwichensis savanna* and *Pipilo e. erythrophthalmus,* the ductus shawi (5) is present and functional on both the left and right sides (Fig. 8).

[1]The numbers after the scientific names indicate the specimen number for materials in the United States National Museum collection, Washington, D. C. Materials not numbered were obtained elsewhere.

In most of the species that were studied, the paired internal mammary arteries arise either as a branch of the coracoid major arteries, or from the subclavian arteries close to the base of the coracoid arteries. This relationship appears to be fairly constant in species of the family Fringillidae.

DISCUSSION

As the writer has previously stated (5), presence rather than absence of the ligamentous vestige of the left radix aorta is to be expected. In addition to the above structure, ligamentous vestiges of the ductus botalli, and occasionally the ductus caroticus or ligamentum caroticum, may be present in different species of birds.

It is the writer's opinion that degeneration of these embryonic vessels is a continuous process and may take place at different rates in different species of birds. This does not mean, however, that the ligamentous vestiges of these embryonic vessels will completely disappear during the adult life of the bird as already has been indicated, but that there is considerable post-embryonic atrophy of some of these embryonic vessels. Evidences for this will be presented in subsequent papers on the late-embryonic condition in the *Rhea*, and common chicken, and the arteries in the Black-billed cuckoo and 10-day-old chick.

It may be pointed out that the greatest similarity in the arrangement of the main arteries and the embryonic vestiges occur between the following species: *Spizella p. passerina* and *Spizella p. pusilla*, *Fringilla coelebs* and *Fringilla montifringilla*, and *Tiaris bicolor omissa* and *Tiaris o. olivacea;* while the greatest differences occur between *Geospiza f. fuliginosa* and *Geospiza s. septentrionalis*, *Emberiza aureola* and *Emberiza flaviventris*, *Loxigilla violacea affinis* and *Loxigilla noctis sclateri*, and *Pipilo fuscus mesoleucus* and *Pipilo e. erythrophthalmus*.

Presence of the ductus shawi in two species of passerine birds is not to be regarded as entirely anomalous, since the presence of this vessel was reported by the author in a previous paper (5). It is the writer's opinion that this vessel may

EXPLANATION OF FIGURES

Figures 1–8: Diagrammatic representations of the main arteries in the neck and thorax regions of the *Fringillidae*, ventral views.

1. Basic arrangement-pattern.
2. Loxipasser anoxantha.
3. Loxigilla violacea affinis.
4. Pipilo fuscus mesoleucus.
5. Richmondena c. cardinalis & Spizella m. monticolla.
6. Leucosticte griseonucha.
7. Commonest arrangement-pattern.
8. Passerculus sandwichensis savanna & Pipilo e. erythrophthalmus.

KEY TO ABBREVIATIONS

1. aortic root.
2. innominate artery.
3. pulmonary artery.
4. subclavian artery.
5. common carotid artery.
6. axillary artery.
7. pectoral arteries.
8. coracoid major artery.
9. internal mammary artery (intercostal artery).
10. left ventral internal artery.
11. left lateral superficial cervical.
12. right ascending oesophagus.
13. right lateral superficial cervical.
14. systemic (right 4th aortic) arch.
15. ligamentum caroticum.
16. ligamentous vestige of left radix aorta and ductus botalli.
17. right ligamentum botalli.
18. right vertebral artery.
19. left vertebral artery.
20. persistant left radix aorta (with lumen).
21. functional right radix aorta.
22. dorsal aorta.
23. ductus shawi (syrinx muscle arteries).

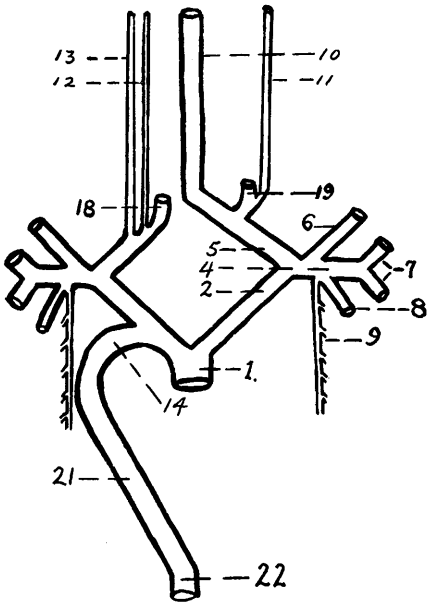
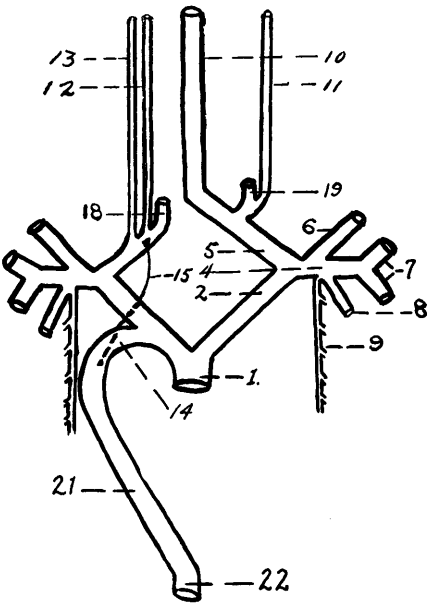


Figure 1



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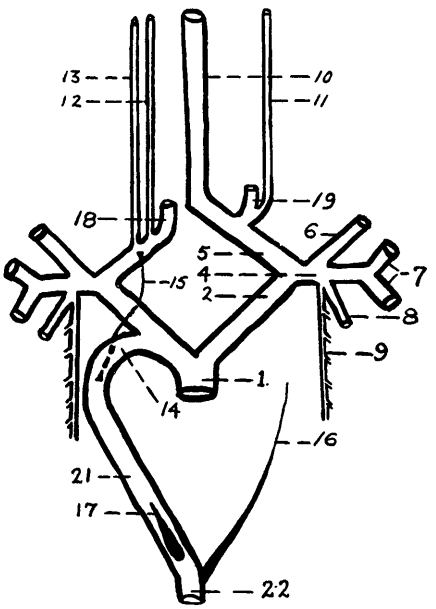

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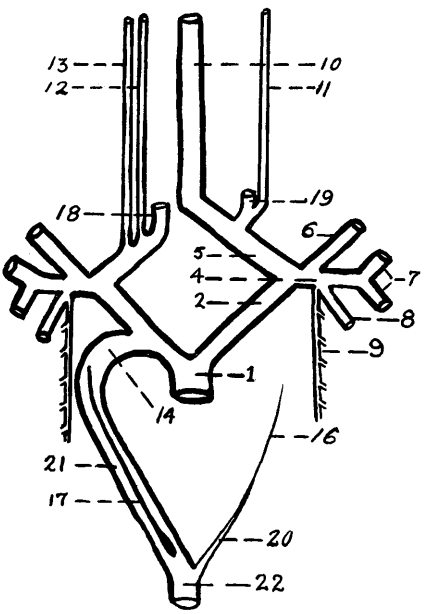

Figure 4

(See page 86 for explanation of figures and abbreviations)

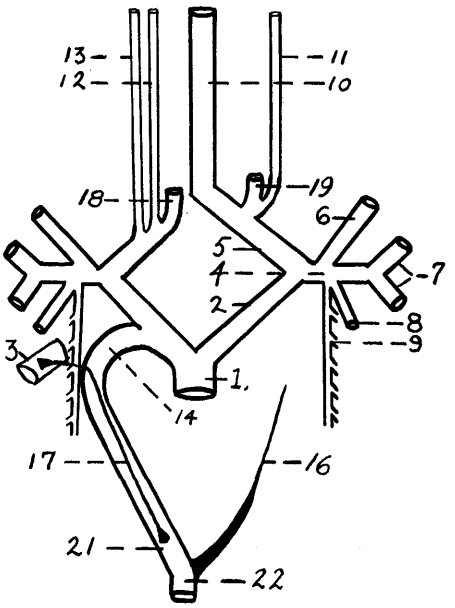

Figure 5

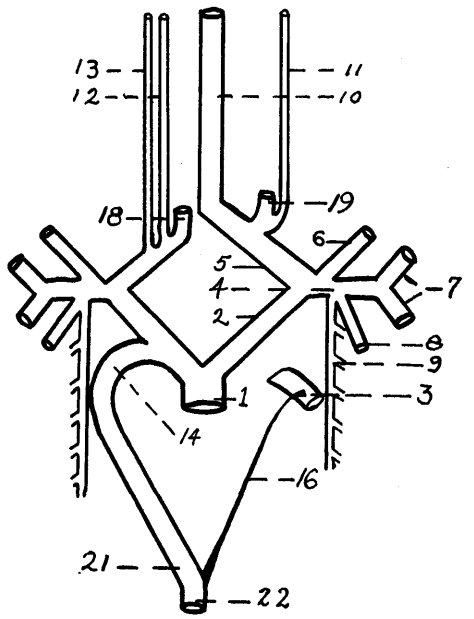

Figure 6

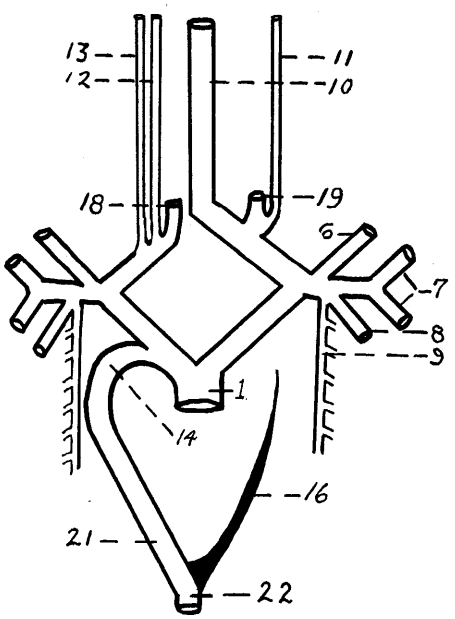

Figure 7

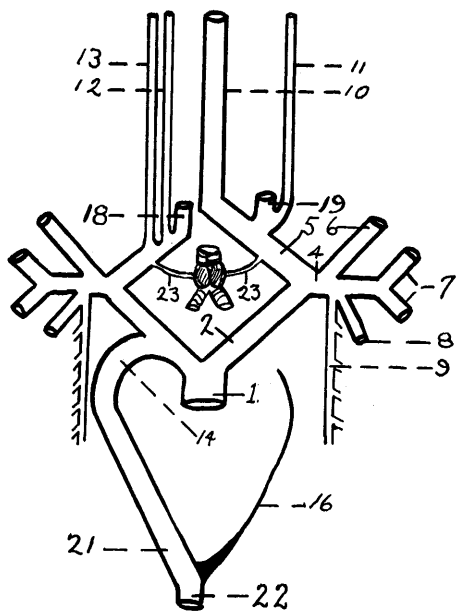

Figure 8

(See page 86 for explanation of figures and abbreviations)

be present in several other species of birds, but goes unrecognized due to its size along with difficulties encountered in ordinary methods of preservation and dissection. It may be that this short vessel is a vestige of the functional embryonic ductus caroticus, but evidence to support this has only recently been obtained.

It may be concluded that passerine birds possess a left common carotid artery, and that this vessel was not observed and recorded by the 19th century workers may have been due to faulty preparation and dissection, or to destruction of this vessel when the specimens were first taken.

In a recent paper (7), Wetmore indicated that it is possible that the Fringillidae have retained and carried more general characters from which further specialization may take place. He further points out that the Coerebidae and Icteridae—specialized families of the fringilline series—may have been derived as modifications from the Fringillidae. This is quite possible in the light of the present evidence, since the Fringillidae show a large number of variations in the arrangement of the arteries, with chief reference to retention of embryonic vestiges. Thus, it should be noted that in this study of 30 species of birds, eight modifications in pattern were observed. Thus far, the Icteridae which have been studied show but one pattern in arterial arrangement. It is likewise possible that slight variation in the basic pattern may be found in later studies, but such wide variations in pattern, as in the Fringillidae, is improbable.

For some time, the writer has been of the opinion that the Fringillidae do not represent the end of a line of evolution, and in this respect, the present studies tend to give increased evidences for Wetmore's contention that the Fringillidae represent the central group through which further progress (evolution) may be expected.

SUMMARY

1. Thirty species of the family Fringillidae were studied and the arrangements of the main arteries in the region of the heart, along with the ligamentous vestiges of certain embryonic vessels, were recorded.

2. The basic pattern for the functional vessels of the adult was found to be the same, but presence of certain embryonic vestiges varied in the different species.

3. The ductus shawi was found to be present and functional in two species.

4. In the majority of specimens, the left radix aorta was present and persisted as a ligament, while the ligamentum botalli persisted in fewer species.

5. The right common carotid artery was present, although earlier workers failed to report its presence, and considered it to be entirely lacking.

6. Although complete degeneration of certain embryonic vessels does not always occur in certain adult birds, it appears that there is some post-embryonic degeneration of these embryonic vessels.

7. The Fringillidae probably represent a central group through which further evolution may be expected.

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